BloombergNEF

The Business Council for Sustainable Energy®

# 2020 Sustainable Energy in America Factbook

## Sustainable Energy and Environment Coalition

February 21, 2020

# About the BCSE

The Business Council for Sustainable Energy (BCSE) is a coalition of companies and trade associations from the energy efficiency, natural gas and renewable energy sectors.

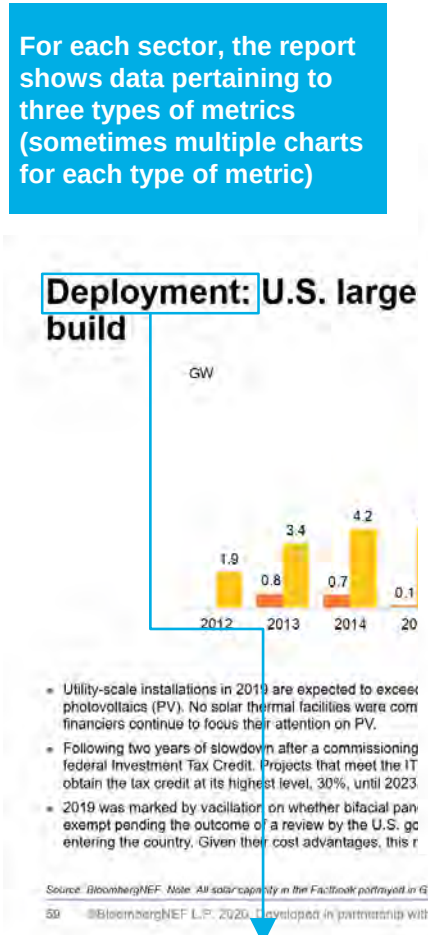
The Council advocates for policies at state, national and international levels that:

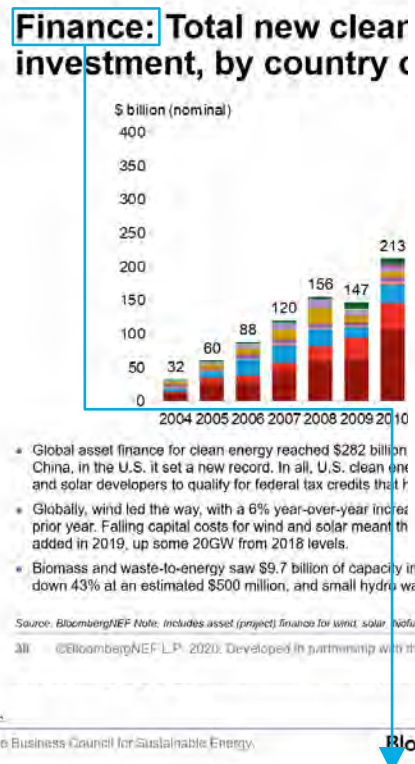
- Increase the use of commercially-available clean energy technologies, products and services;
- Support an affordable, reliable power system; and
- Reduce air pollution & greenhouse gas emissions.

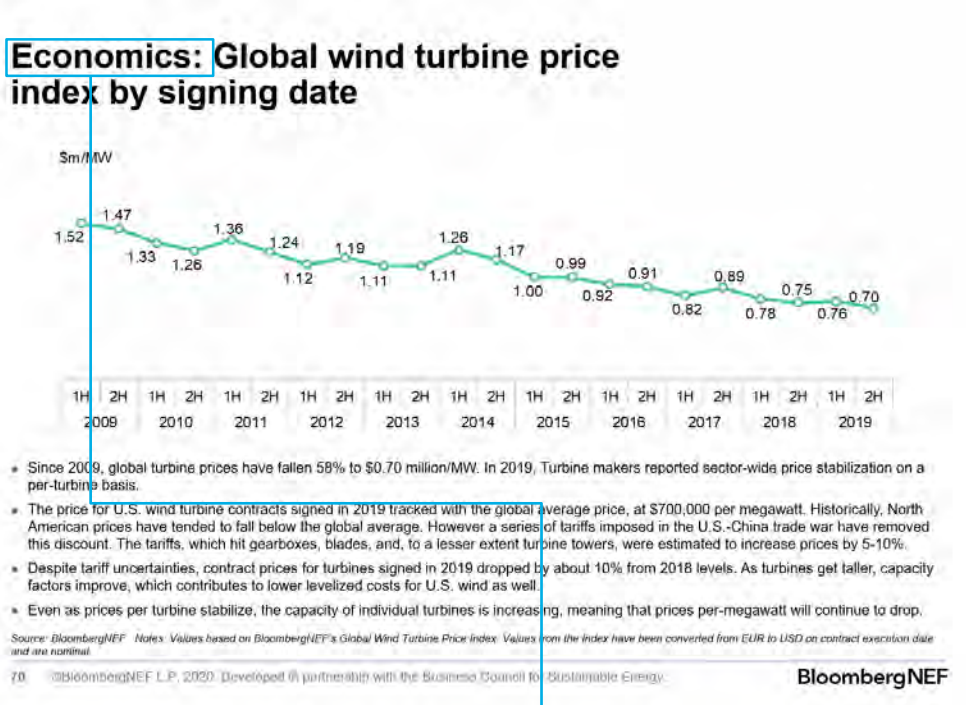

cebn.org/faces-behind-the-facts/

# About the Factbook: The sub-sections within each sector

**For each sector, the report shows data pertaining to three types of metrics (sometimes multiple charts for each type of metric)**




**Deployment**: captures how much activity is happening in the sector, typically in terms of new build or supply and demand

**Finance**: captures the amount of investment entering the sector

**Economics**: captures the costs of implementing projects or adopting technologies in the sector



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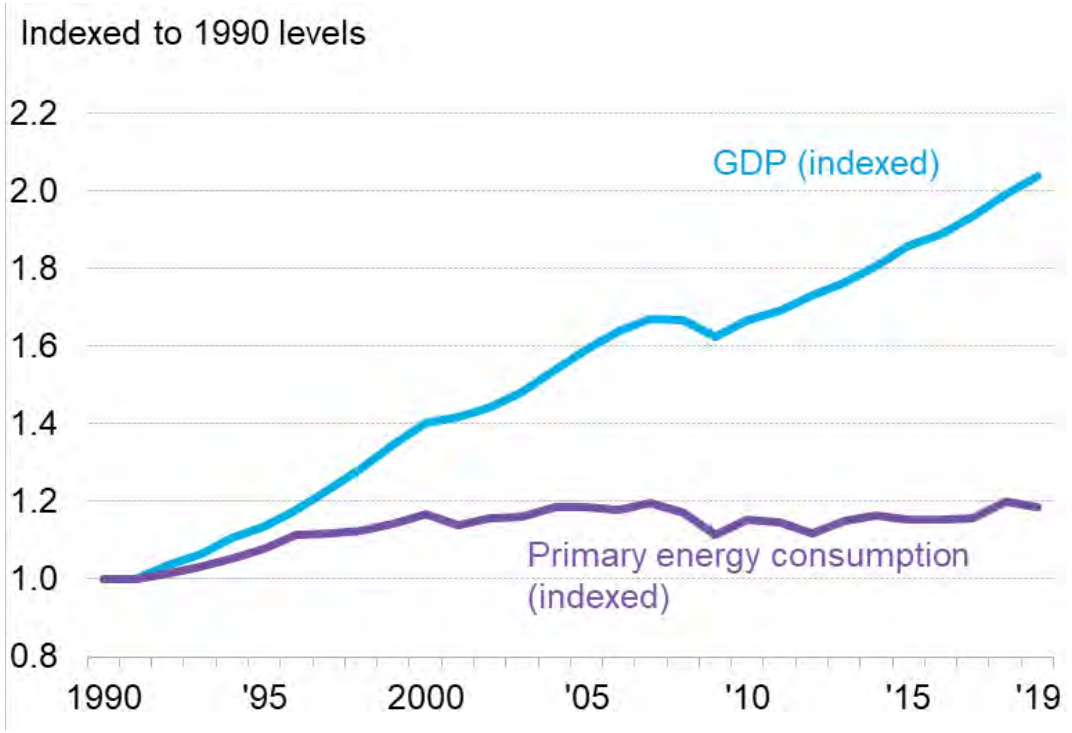
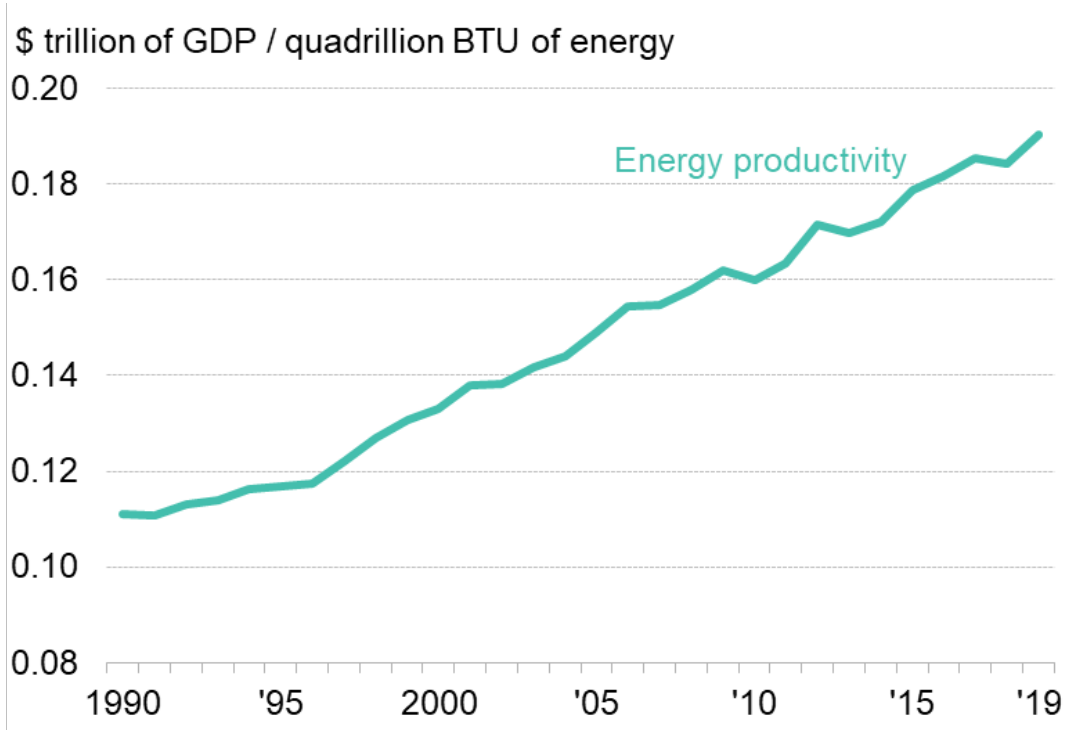
# U.S. energy overview: Productivity

## U.S. GDP and primary energy consumption



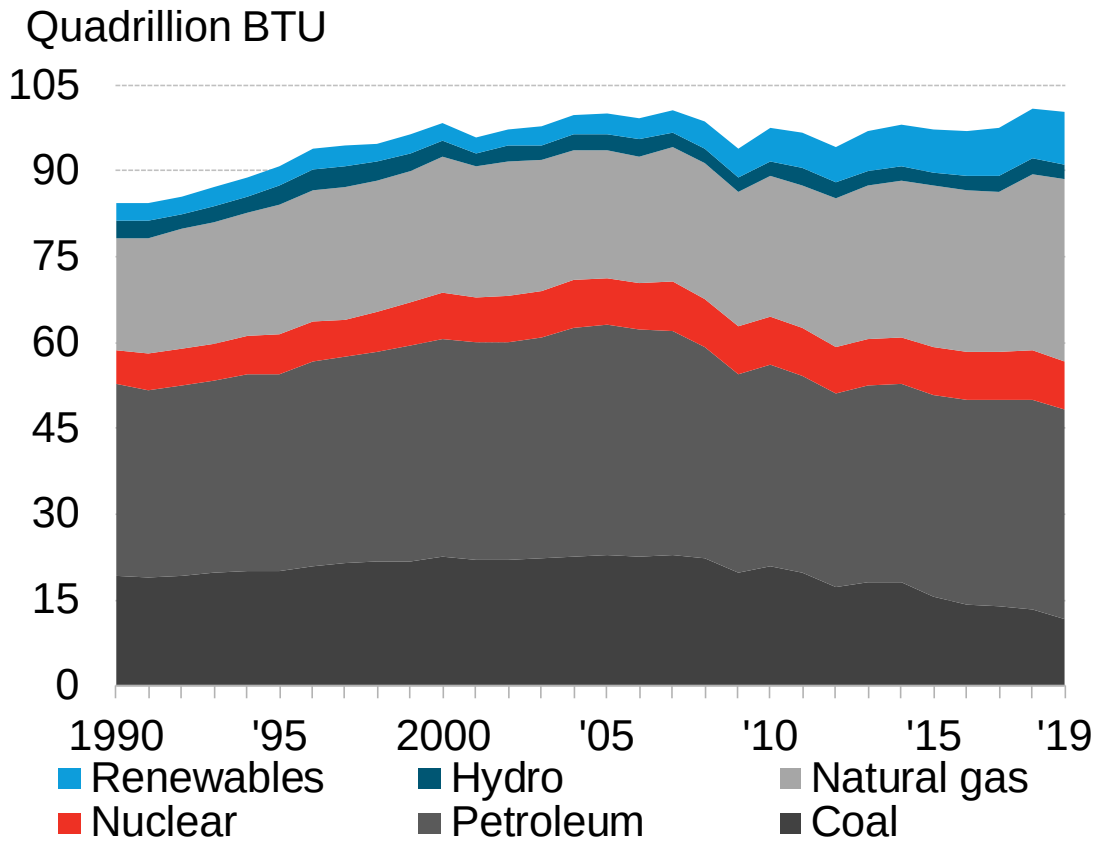

## U.S. energy productivity



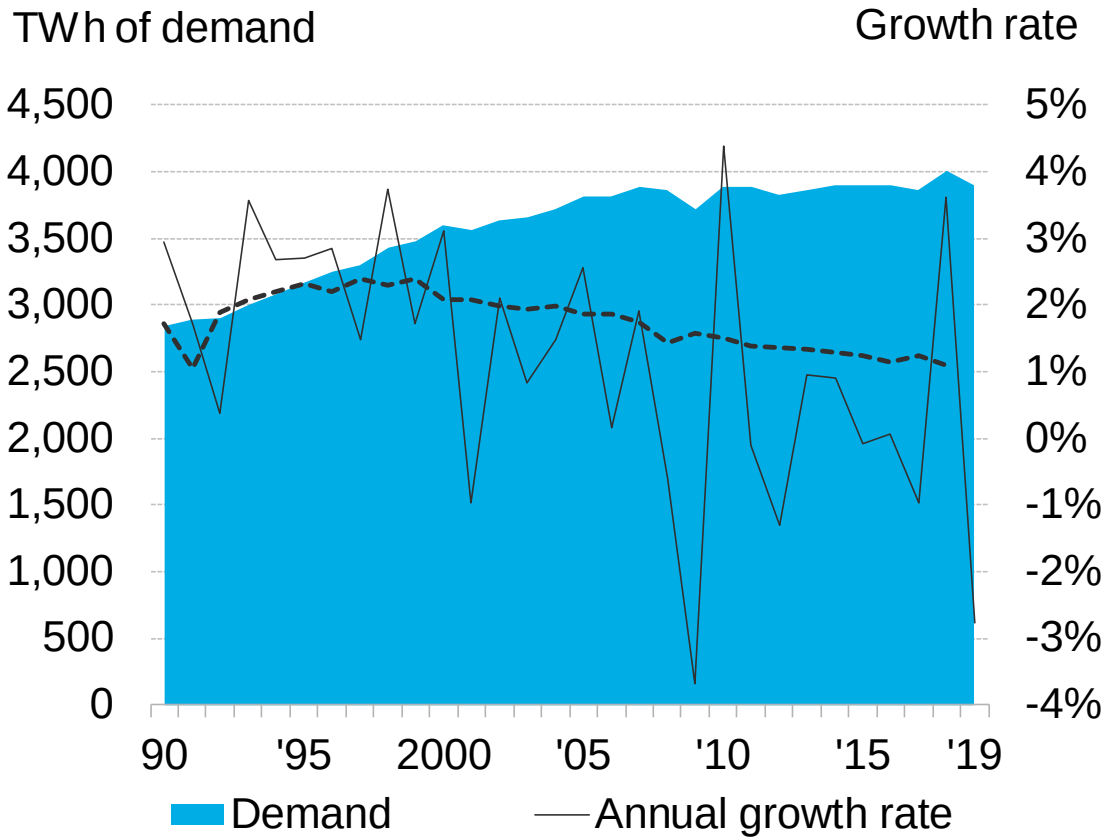

*Source: Bureau of Economic Analysis, EIA, BloombergNEF  Notes: Values for 2019 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through September 2019). 2019 GDP estimate is a projection from economists compiled at ECFC <GO> on the Bloomberg Terminal.*

# U.S. energy overview: Energy and electricity consumption

## U.S. primary energy consumption, by fuel type



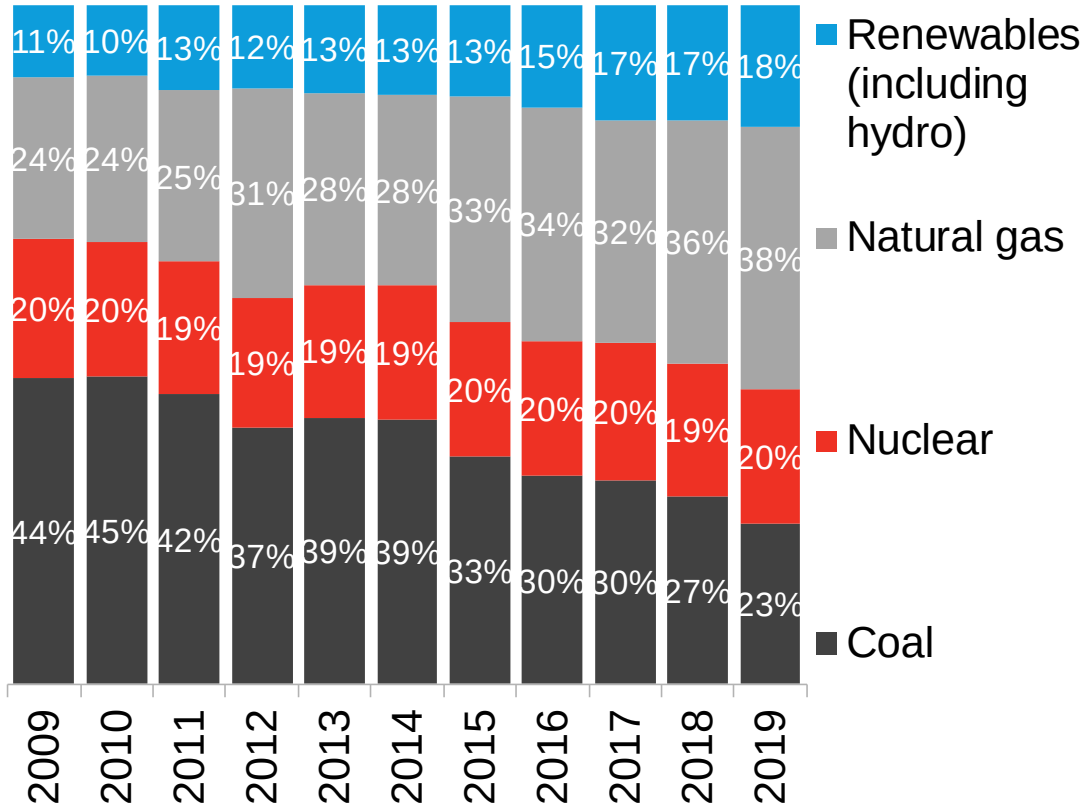

## U.S. electricity demand



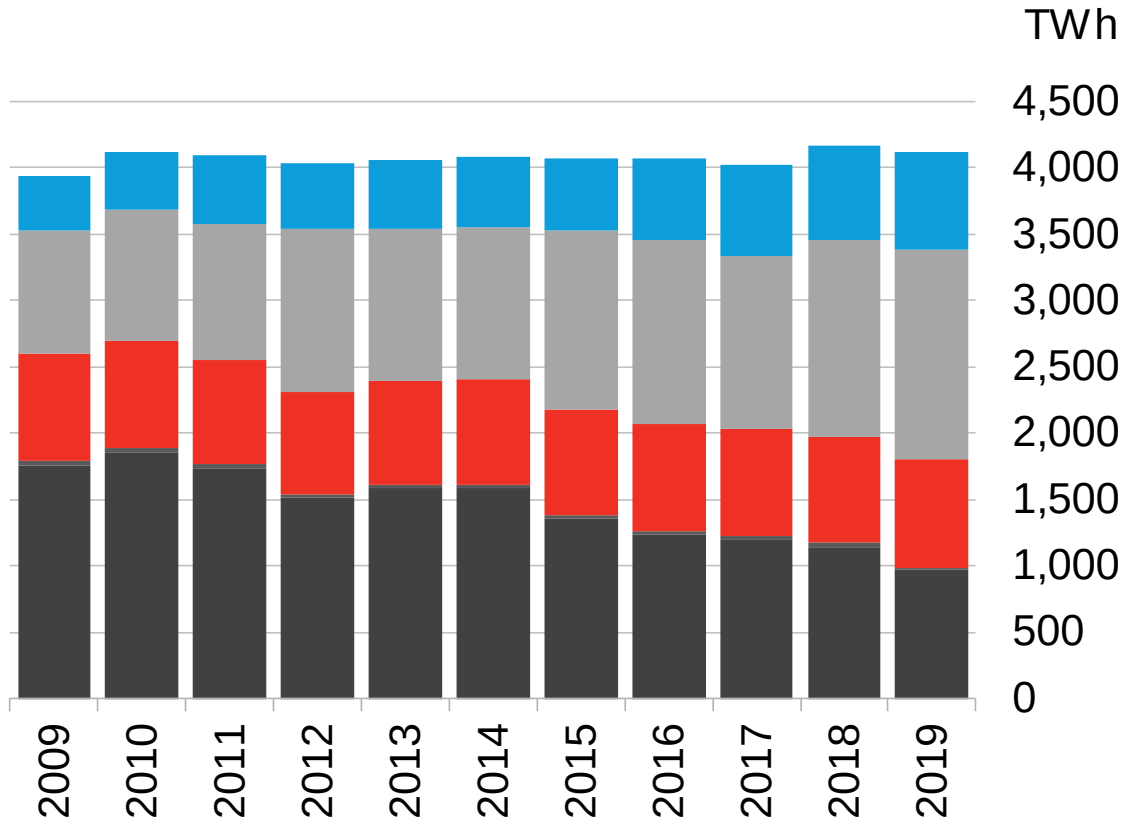

*Source: EIA, BNEF Notes: "CAGR" on the right hand side graph is compound annual growth rate. Values for 2019 are projected, accounting for seasonality, based on the latest monthly values from EIA (data available through September 2019). BTU stands for British thermal units.*

# U.S. energy overview: Electricity generation mix

## U.S. electricity generation, by fuel type

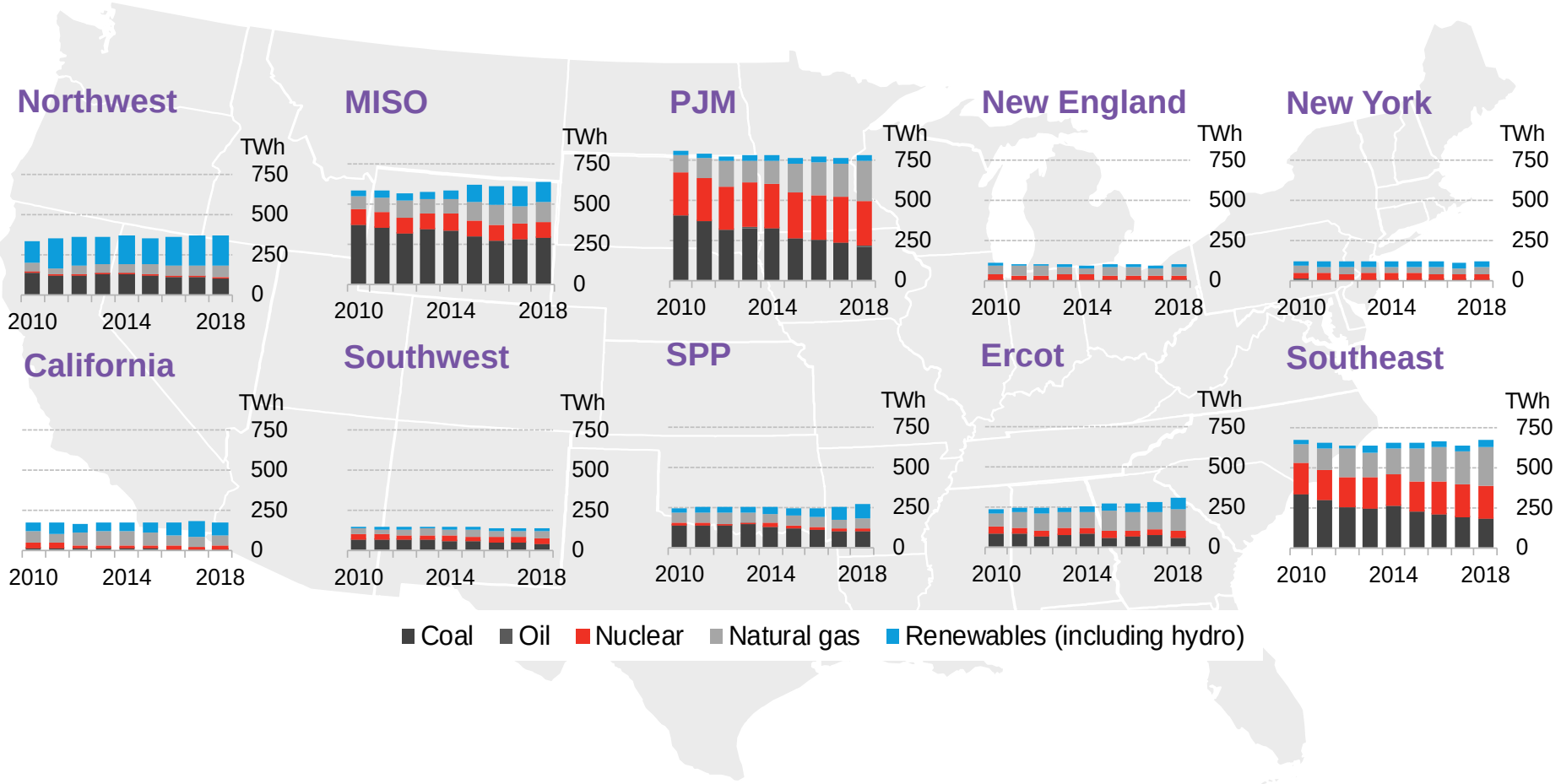



## U.S. electricity generation, by fuel type




*Source: EIA, BloombergNEF Note: Values for 2019 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2019)*

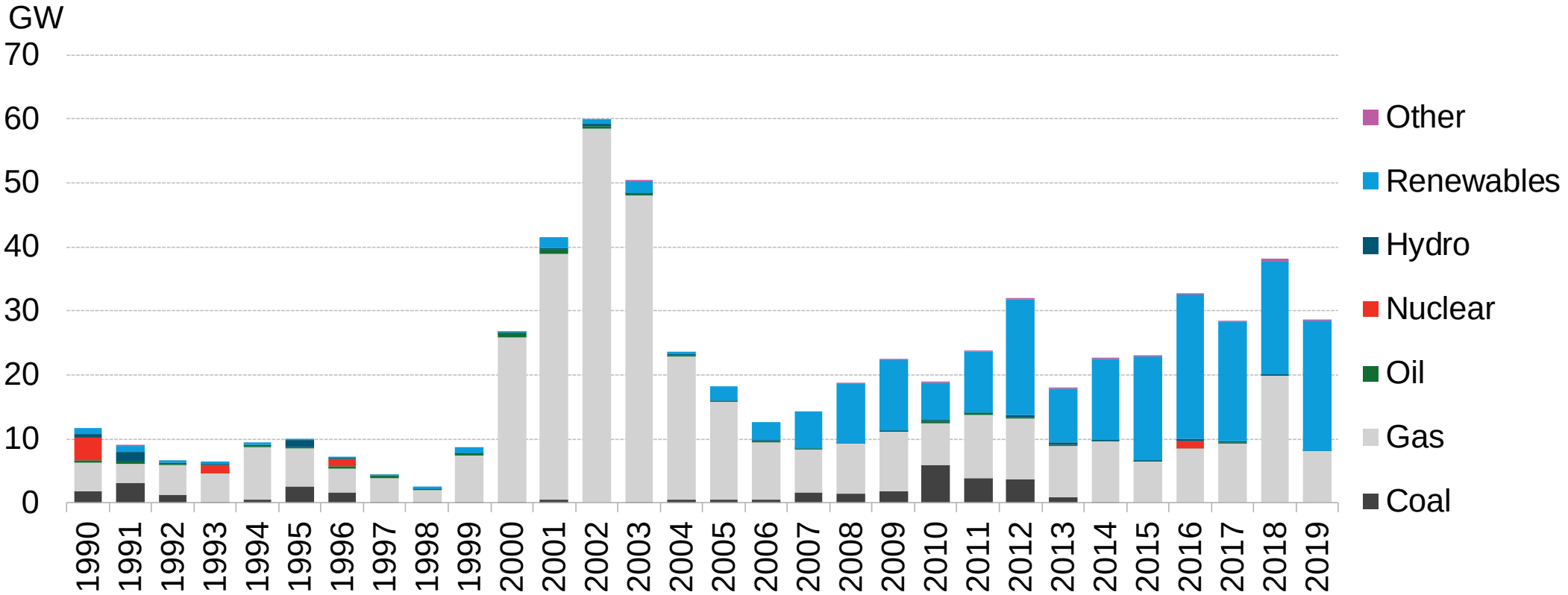
# U.S. energy overview: Electricity generation mix by U.S. power market




*Source: EIA, BloombergNEF Notes: MISO is the Midwest region; PJM is the Mid-Atlantic region; SPP is the Southwest Power Pool which covers the central southern U.S.; Ercot covers most of Texas.*

# U.S. energy overview: Electric generating capacity build by fuel type

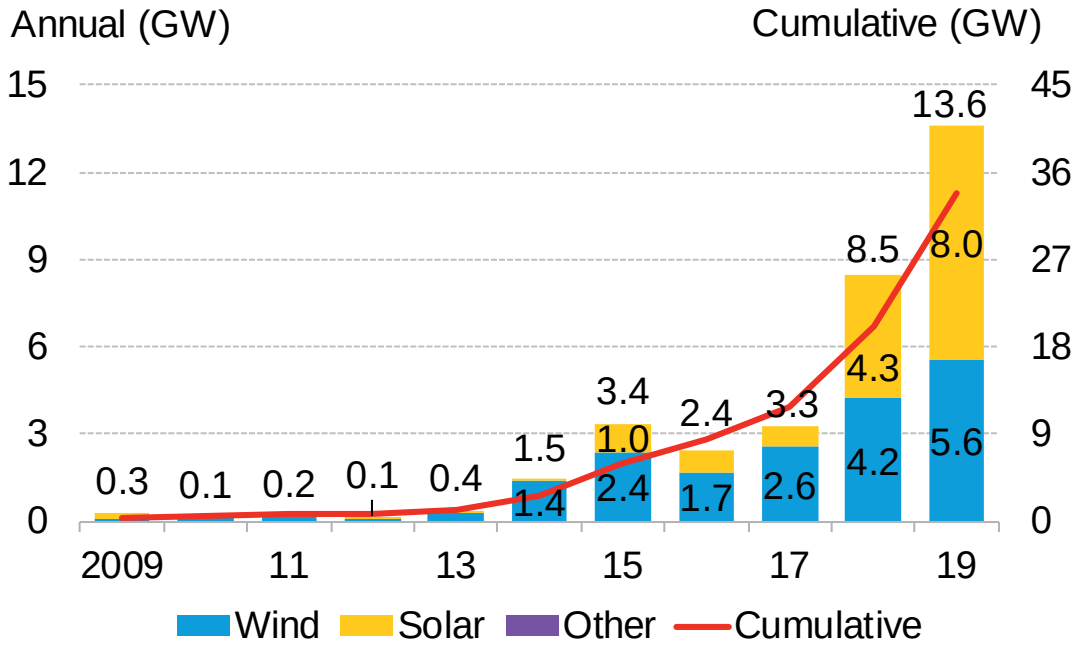
## U.S. electric generating capacity build, by fuel type



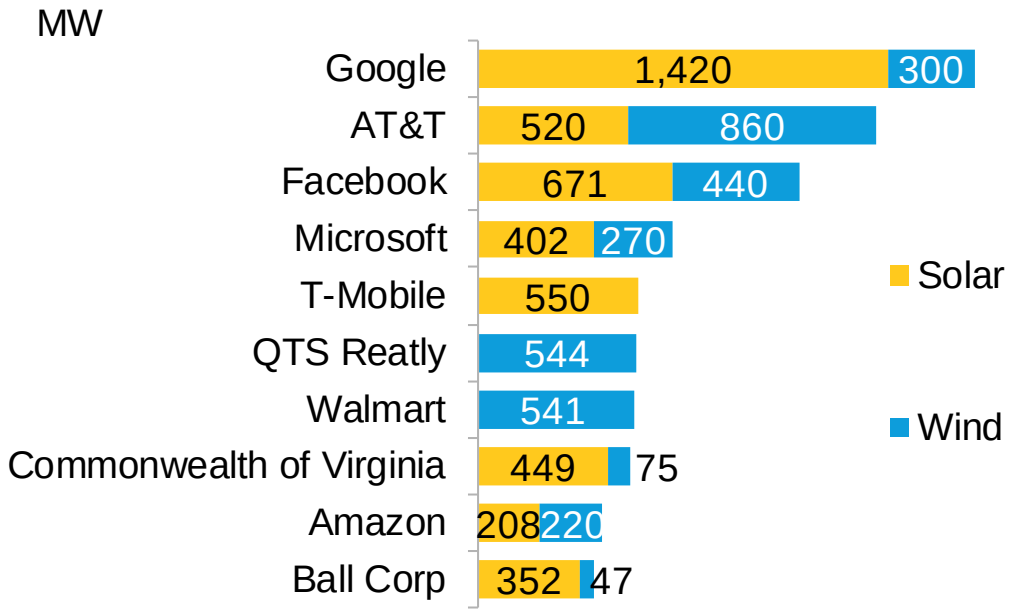

*Source: EIA, BloombergNEF Note: All values are shown in AC except solar, which is included as DC capacity. "Renewables" here does not include hydro, which is shown separately. All capacity figures represent summer generating capacity. Includes installations or planned installations reported to the EIA through October 2019, as well as BloombergNEF projections.*

# Corporate procurement of renewable power

## U.S. corporate PPAs, by technology



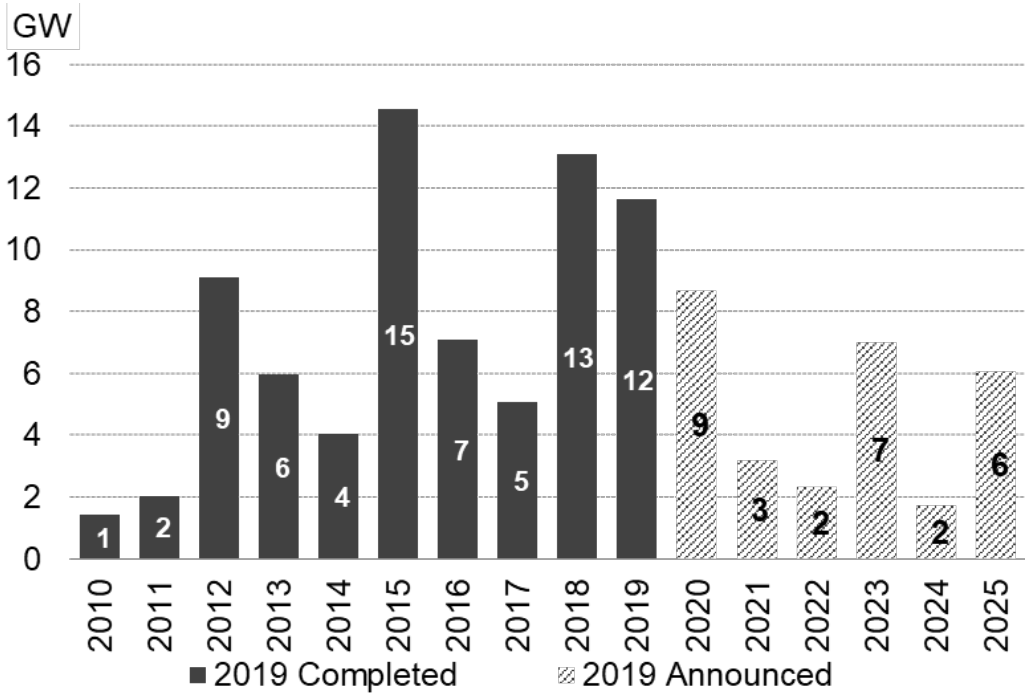

## Largest corporate offtakers, 2019



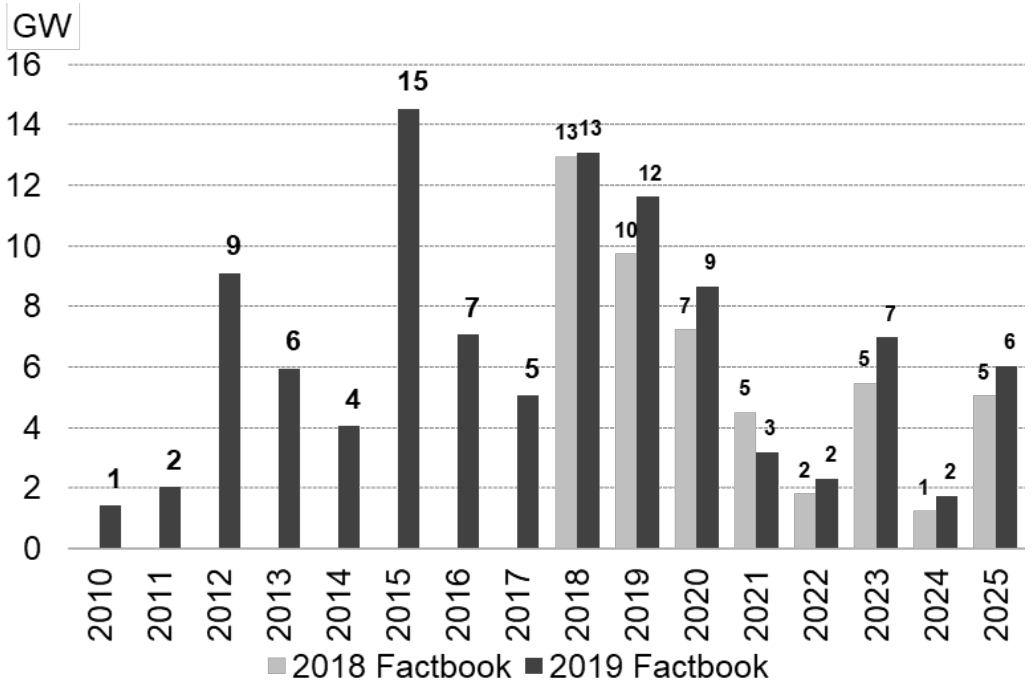

*Source: BloombergNEF Note: Charts show offsite PPAs only*

# U.S. energy overview: Completed and announced coal-fired plant retirements

## U.S. coal retirements, by type



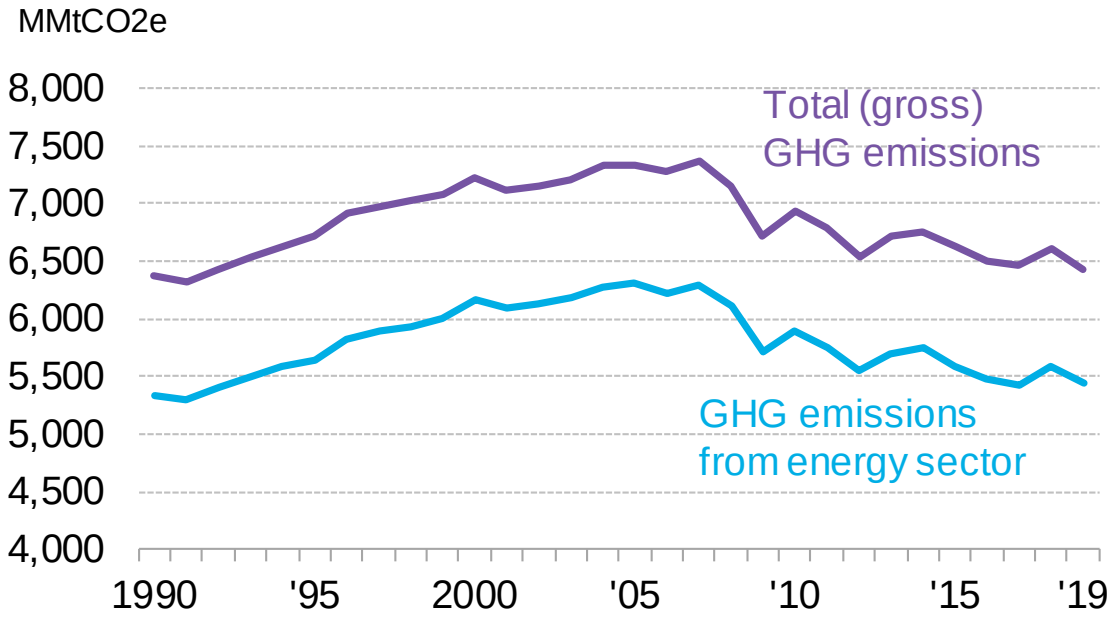

## Total U.S. coal retirements, 2018 vs 2019



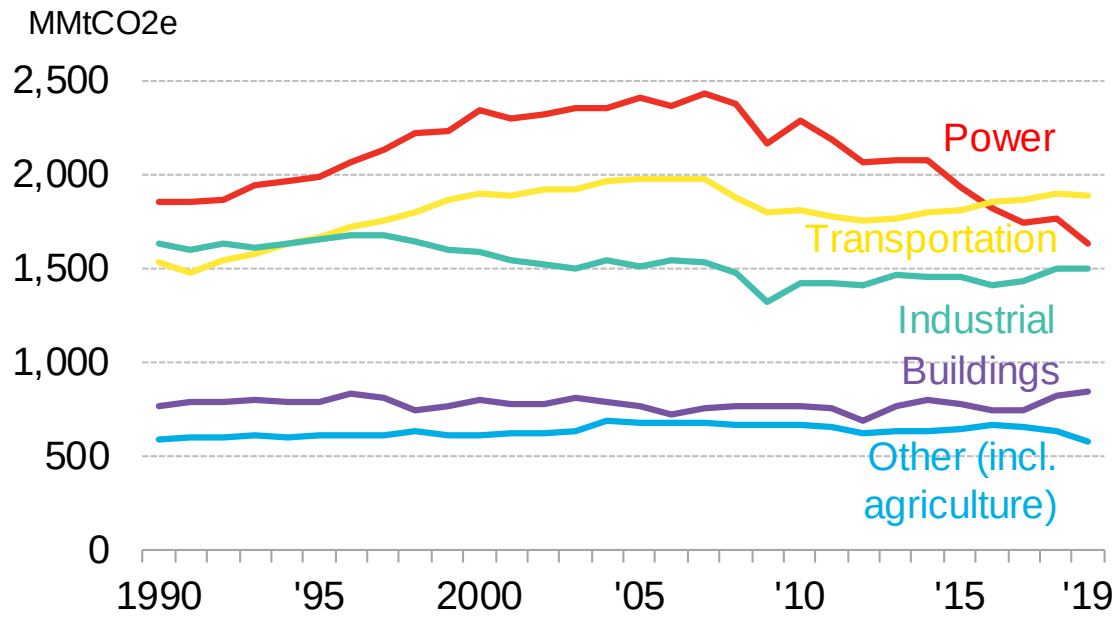

*Source: EIA, company announcements, BloombergNEF  Notes: "Retirements" does not include conversions from coal to natural gas or biomass; includes retirements or announced retirements reported to the EIA through October 2019. All capacity figures represent summer generating capacity.*

# U.S. energy overview: Greenhouse gas (GHG) emissions

## Economy-wide and energy sector emissions

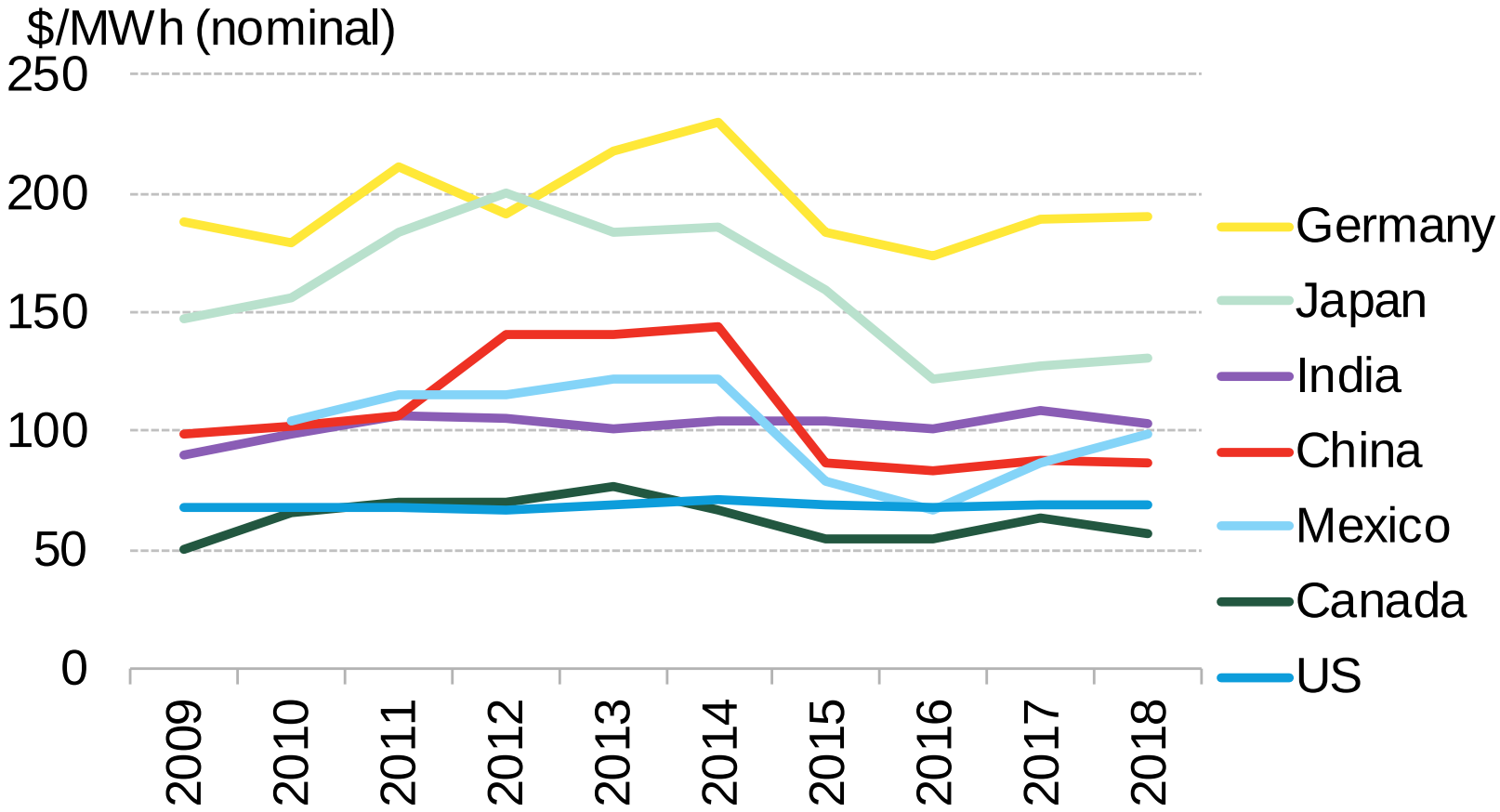



## Emissions by sector




*Source: BloombergNEF, EIA, EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016 Notes: "Sinks" refer to forests and green areas which absorb carbon dioxide. Values for 2019 are projected, accounting for seasonality, based on monthly values from EIA available through September 2019.*

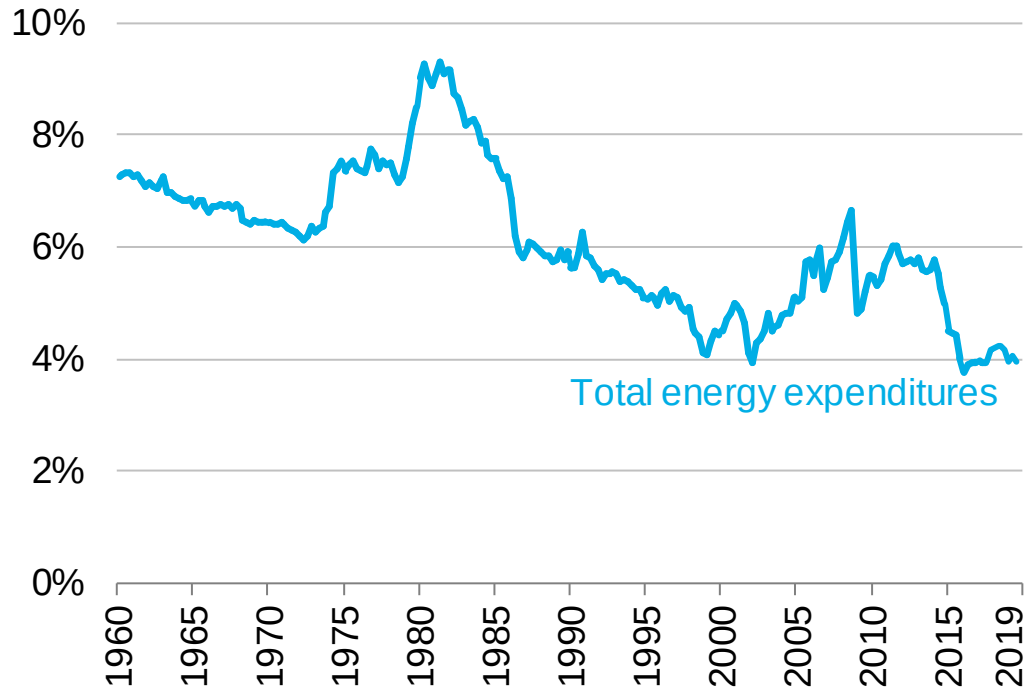
# Industrial power prices compared



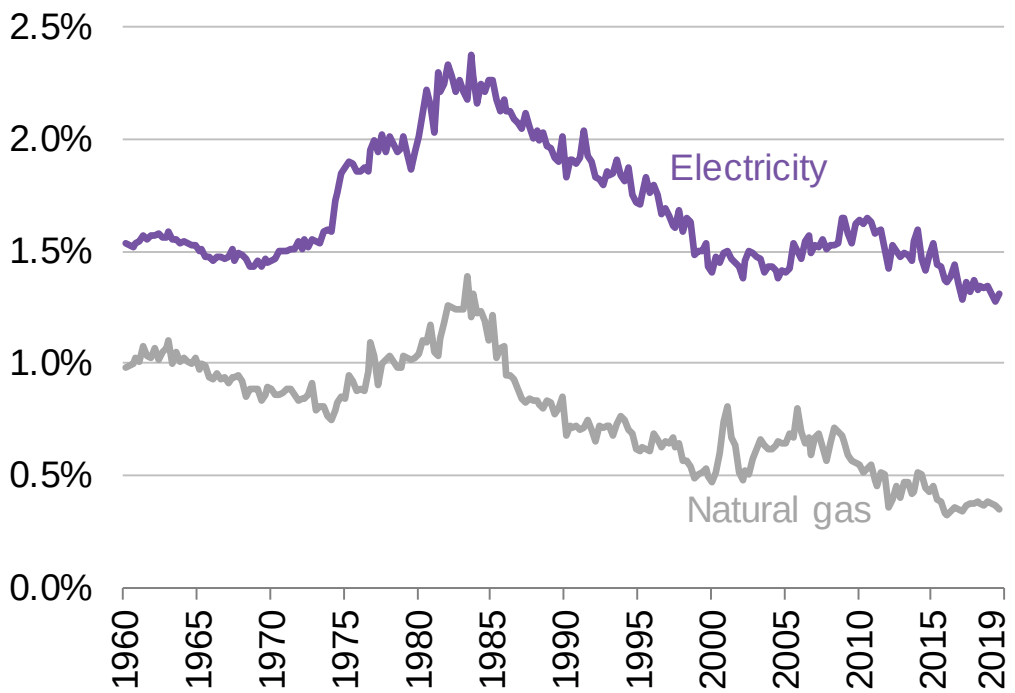

*BloombergNEF, government sources (EIA for the U.S.) Notes: Prices are averages (and in most cases, weighted averages) across all regions within the country. Japanese data is for the C&I segment and 2016 figures come from a different source than preceding years.*

# Energy as a share of personal consumption expenditures

## Total energy goods and services as share of total consumption expenditure



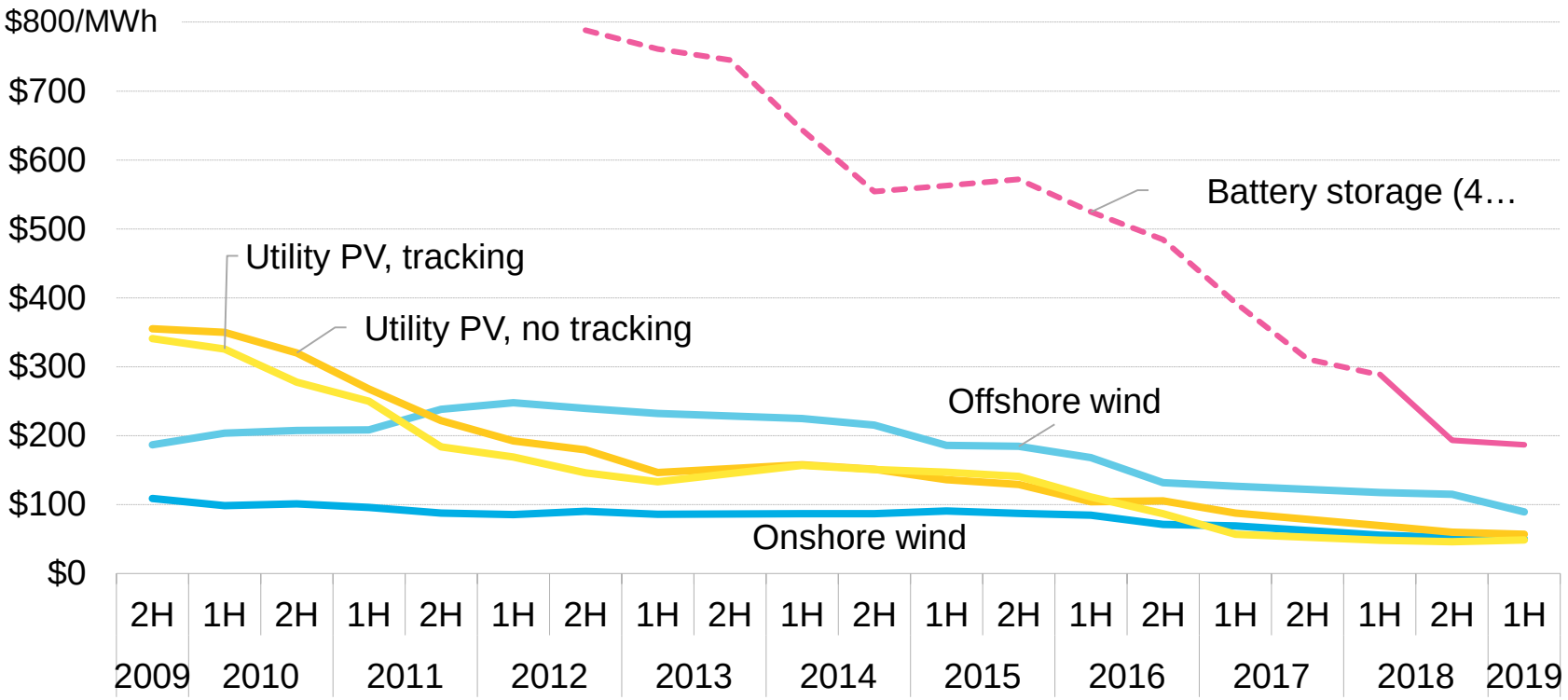

## Electricity and natural gas as share of total consumption expenditure




*Source: Bureau of Economic Analysis, BloombergNEF*

# The cost of renewable power generation has dropped significantly

## Levelized cost of energy (nominal)




## Learning rates

**15%**
Onshore wind

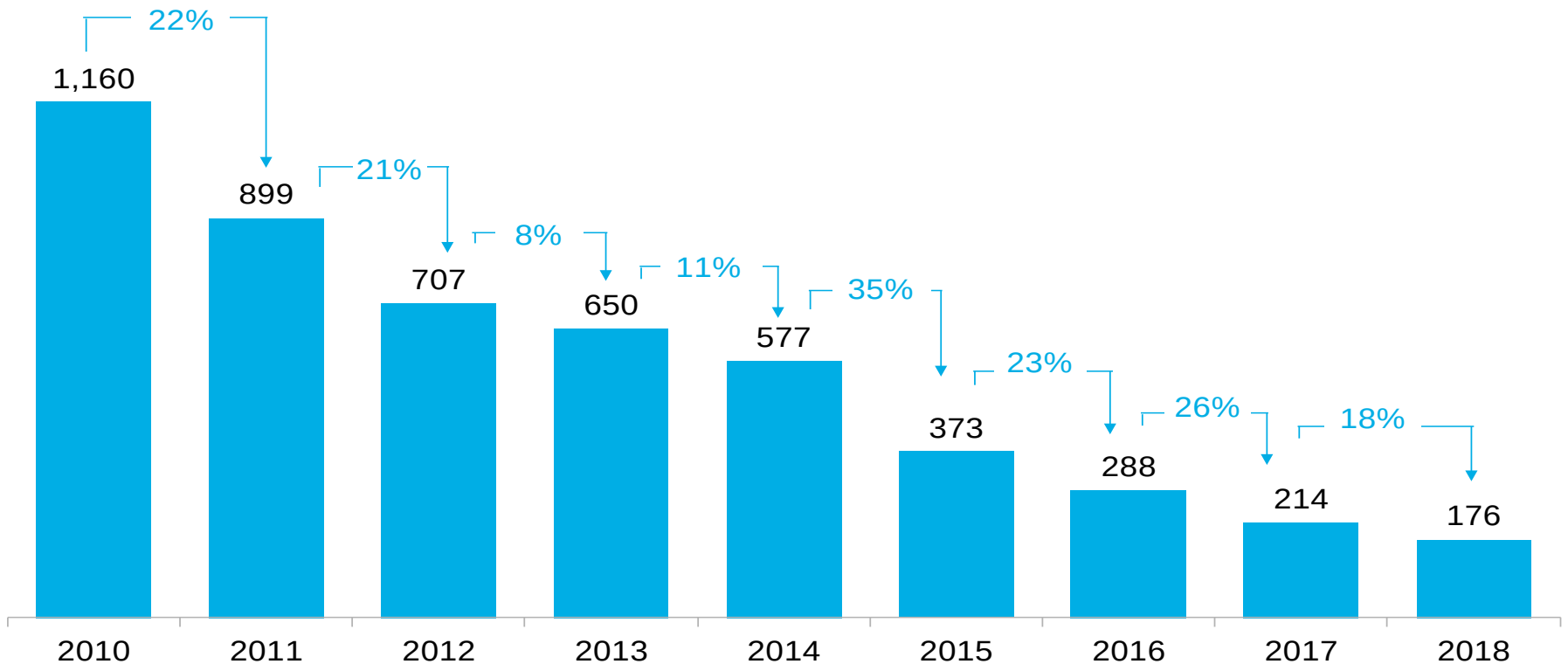
**28.5%**
Solar

**18%**
Batteries

*Source: BloombergNEF*

# Lithium-ion battery storage prices have dropped 85%

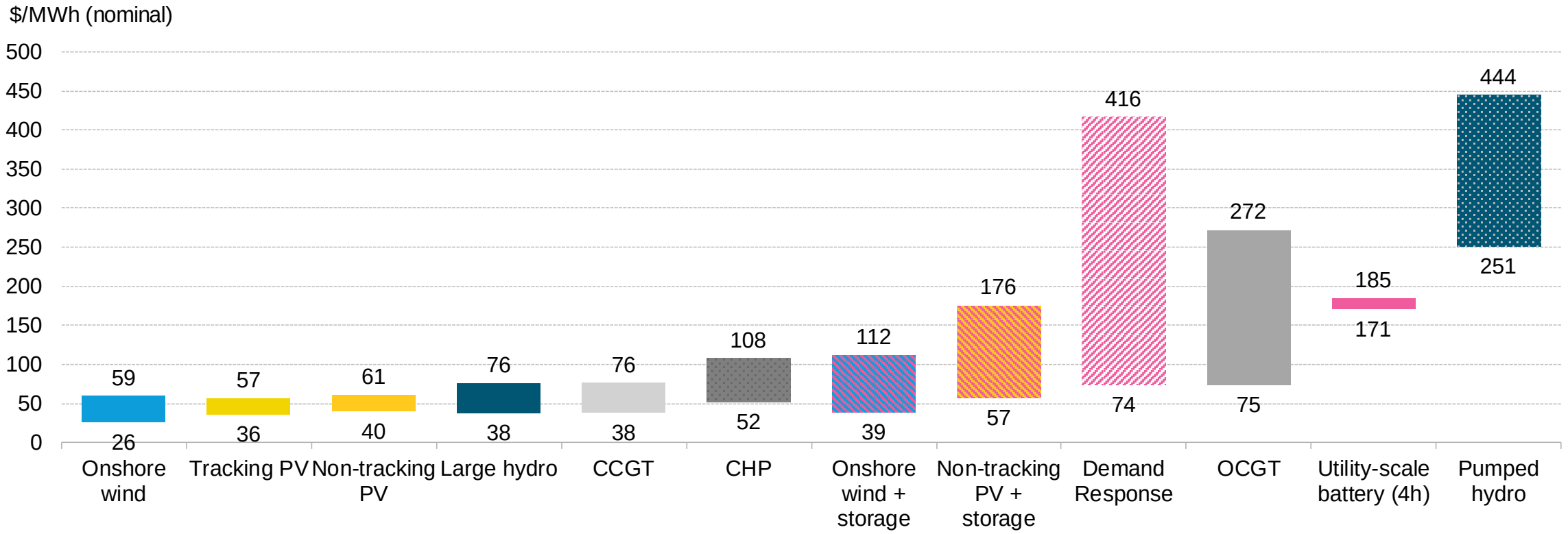
## Volume-weighted average battery pack price (real 2018 $/kWh)




-85%
2010 - 2018

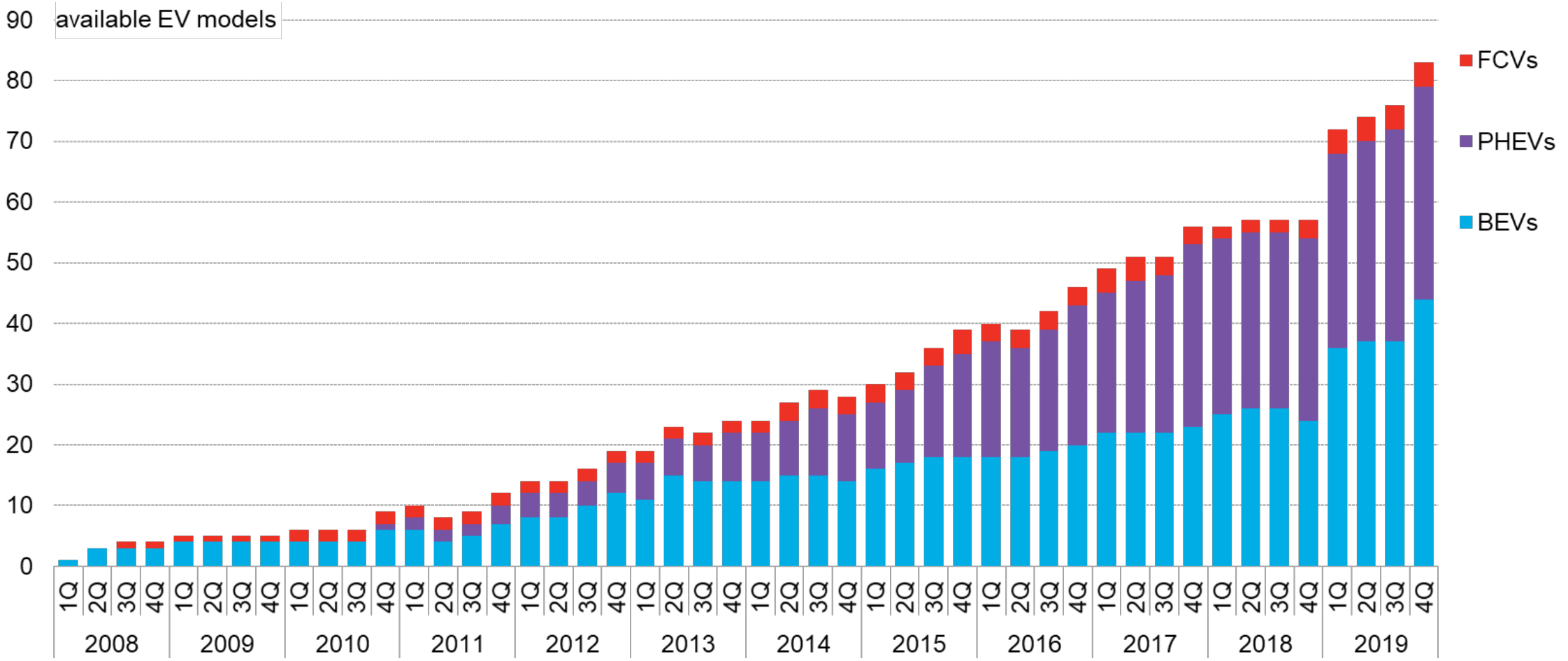
*Source: BloombergNEF*

# Economics: U.S. levelized costs of electricity (unsubsidized for new build, 2H 2019)




*Source: BloombergNEF. Note: The LCOE range represents a range of costs and capacity factors. Battery storage systems (co-located and stand-alone) presented here have four-hour storage. In the case of solar- and wind-plus-battery systems, the range is a combination of capacity factors and size of the battery relative to the power generating asset (25% to 100% of total installed capacity). All LCOE calculations are unsubsidized. Categorization of technologies is based on their primary use case.*

# Deployment: Electric vehicle and fuel cell vehicle model availability in North America




*Source: BloombergNEF, Marklines. Note: EV includes BEVs and PHEVs. FCV stands for fuel cell electric vehicle, PHEV stands for plug-in hybrid electric vehicle and BEV stands for battery electric vehicle. Data as of November 26, 2019.*

# The Sustainable Energy Decade *headlines*

**How the U.S. generates, delivers, and consumes energy profoundly changed during the 2010's**

*Production*

- At the well-head: gas production jumped >50%.
- At the power plant:
  - Gas-fired power generation went from meeting 24% (2010) of electricity demand to 38% (2019).
  - Conversely, coal-fired power generation dropped from 45% to 23%.
  - Renewables generation jumped 77%, 2010-2019 to contribute 18% in 2019. Capacity more than doubled.
- 38% of U.S. power in 2019 was zero-carbon. Renewables + gas generation: 56%. Renewables + nuclear + gas = 76%

*Delivery*

- Gas distribution pipelines grew from 2.09 million to 2.24 million miles (through 2018) with $185 billion invested in midstream.
- 2010-2018 (last year of complete data): $170 billion spent by investor-owned utilities on expanding transmission.

*Consumption*

- GDP grew every year of the decade, but energy consumption year-on-year actually *shrank* in five of them.
- GDP grew by ~one quarter, but total energy use grew just 6.6%.  Energy productivity improved through the decade.
- Deployment of more energy efficient devices and services:
  - Smart meters: 10 million -> 85 million
  - LED's: ~0 -> 1.1 billion (just through 2018).

# The Sustainable Energy Decade *headlines*

*Energy security*

- The U.S. started the decade as a net importer of ~10m barrels of oil per day. Ended 2019 at ~0 (on a net basis).
- The U.S. switched from being a net gas importer to a net exporter.

*Investment*

- $390 billion invested in U.S. renewable energy assets over a decade (pre-2010 cumulative: $100 billion)
- 3.5 million Americas working in efficiency, energy storage, renewables, nuclear and gas.

*Emissions*

- U.S. power sector emissions of harmful greenhouse gases dropped by near 1/4. Economy-wide, emissions dipped 4.1%.
- The U.S. power is no longer the primary source of U.S. emissions.

*The benefit to consumers*

- Natural gas, wholesale power, and retail power prices are all down since a decade ago (with variation by region).
- More consumer choices: at the pump, in the automobile showroom, at home.
- U.S. households putting less than 4% of their monthly average income toward energy-related expenses, down from 5.1% a decade ago.

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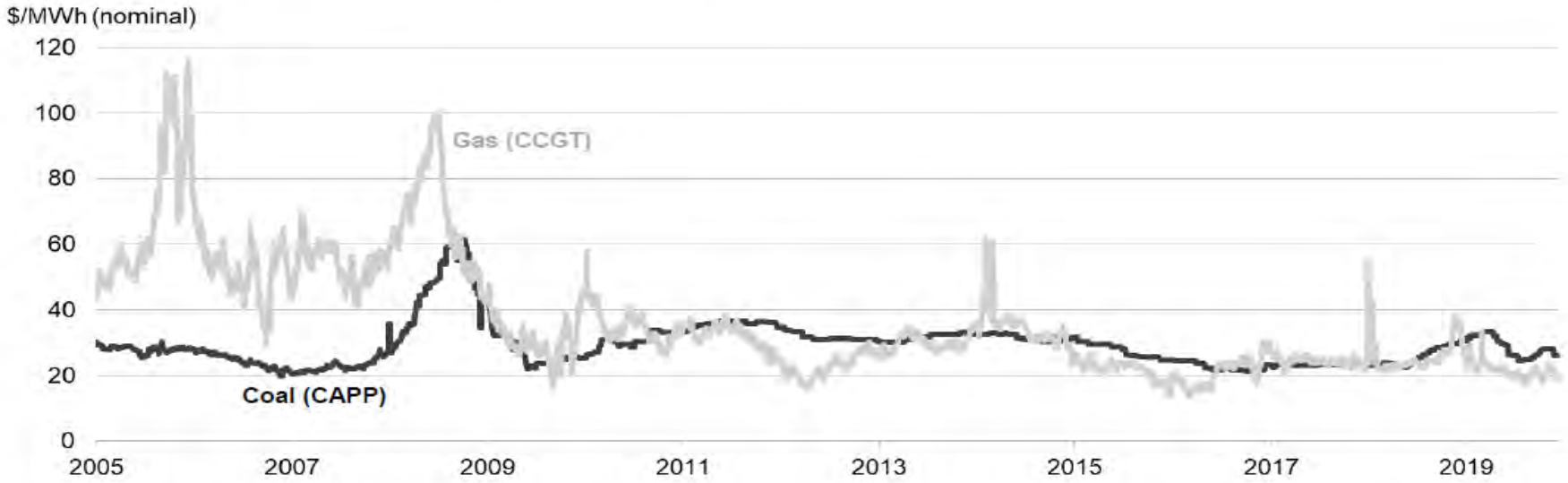
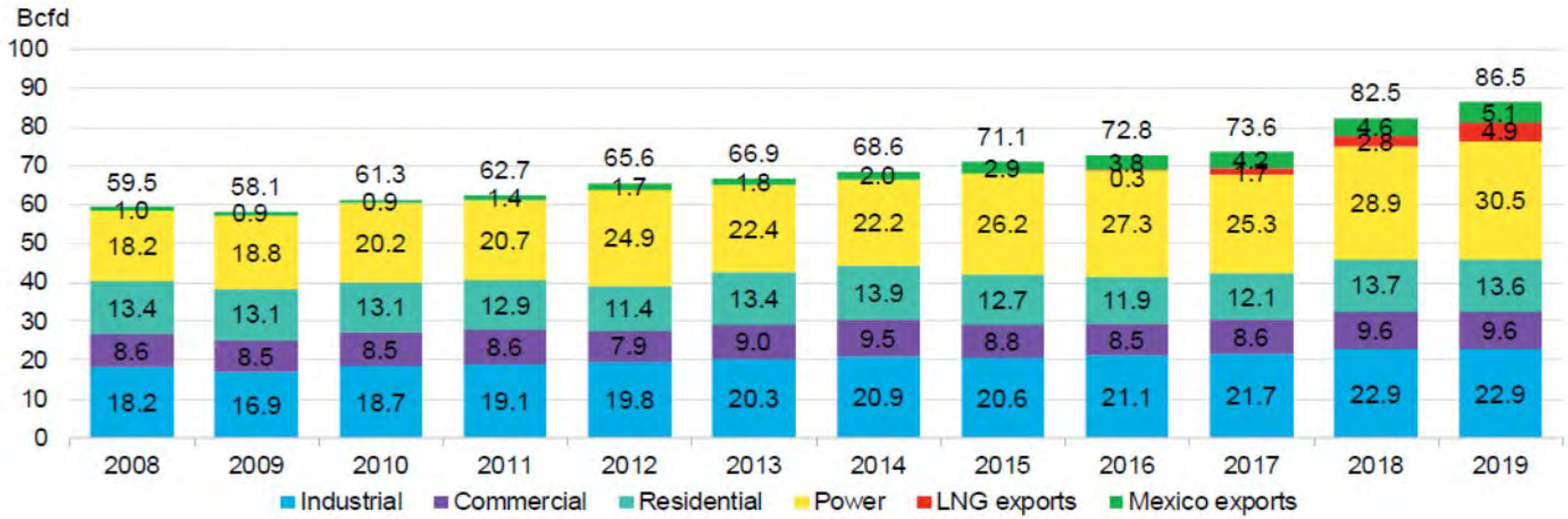
# Economics: Generating electricity from natural gas vs. coal in the U.S.




- In the U.S., power is the primary source of gas demand price elasticity. When the price of gas falls below that of coal, gas burn rises until the price differential (in $/MWh) between the two fuels closes.
- The 2019 increase in natural gas demand was due to both structural and market changes. Coal-burning capacity was reduced by 12GW in 2019, while 8.2GW of new natural gas-fired capacity was added. About 3.8GW of un-economic gas-fired generation was retired, but the impact on gas demand was minimal due to low capacity factors.
- Gas prices had to realize cheaper than equivalent coal prices during most of 2019 in to order increase demand and slow the pace of injection refills.

*Source: BloombergNEF Notes: Assumes heat rates of 7,410Btu/kWh for CCGT and 10,360Btu/kWh for coal (both are fleet-wide generation-weighted medians); variable O&M of $3.15/MWh for CCGT and $4.25/MWh for coal. Gas price used is Henry Hub. CCGT stands for a combined-cycle gas turbine. CAPP represents Appalachian coal prices.*

# Deployment: U.S. natural gas demand by end use

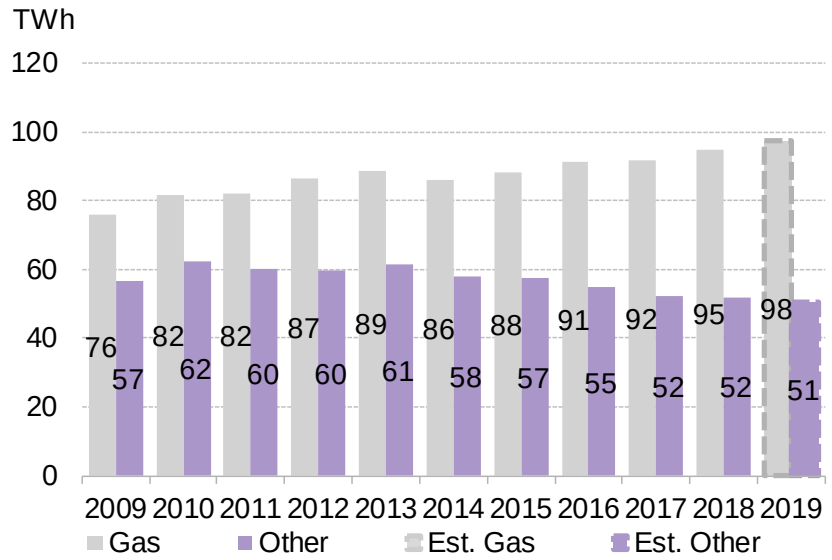



- Total U.S. annual gas demand has grown 49% in the past decade and 5% in the last year alone to a record-setting 86.5 Bcfd in 2019.
- Power generation gas demand grew by 1.6Bcfd, despite a cooler summer. 12GW of coal-fired power plant retirements and lower year-on-year gas prices boosted demand.
- Industrial, residential and commercial heating demand held flat in 2019, thanks to a repeat relatively cold winter.
- LNG exports also significantly contributed to demand increase; 25MMtpa of new liquefaction capacity came online in 2019. However, this capacity had a utilization factor of less than 90%, due to technical issues at some of the newest plants.

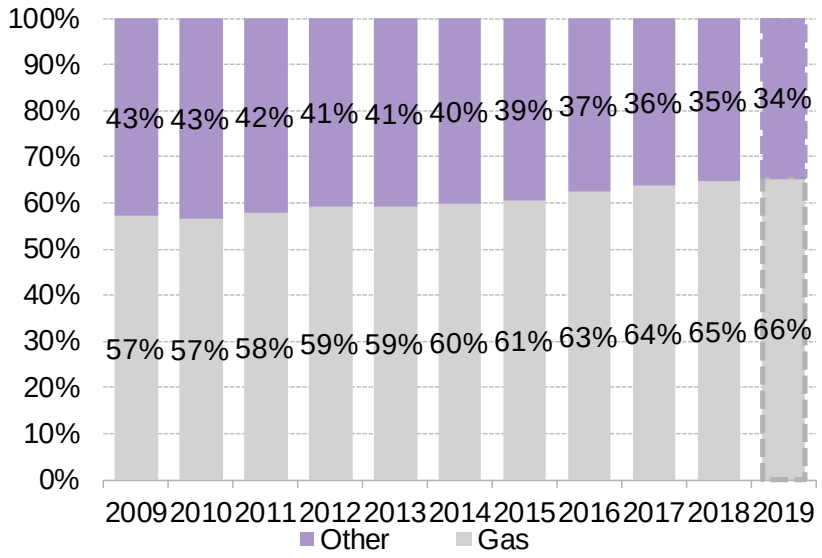
*Source: BloombergNEF, EIA. Note: Values for 2019 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2019).*

# Deployment: Industrial on-site power generation, by type of fuel

### Industrial, on-site power generation, TWh




### Industrial, on-site power generation, % total




- The industrial sector's energy consumption has risen 24% over the last decade and now accounts for 23% of total U.S. primary energy demand. The sector's total emissions of harmful greenhouse gases rose at a slower, 14% pace over the same period. The industrial sector now accounts for 23% of total U.S. GHG emissions.
- Industrial sector, on-site power generation is when electricity is produced at an industrial plant's premises rather than coming from the grid. From 2018 to 2019, on-site industrial power generation rose 1%. Since the start of the decade it is up 12%.
- In 2019, natural gas was responsible for an estimated 98TWh of on-site generation at industrial facilities. Other sources provided an additional 51TWh. In total, industrial on-site generation increased 1.5TWh over 2018 levels. This uptick is driven by gas-based generation's 2.7TWh increase as gas displaced other, more expensive fuels, namely coal. The percent of on-site generation provided by gas has increased in the last decade, from 57% in 2009 to 66% 2019. This shrunk the size of an otherwise more carbon-intensive, coal-dominated fuel mix.

*Source: BloombergNEF, EIA; Note: Values for 2019 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2019)*

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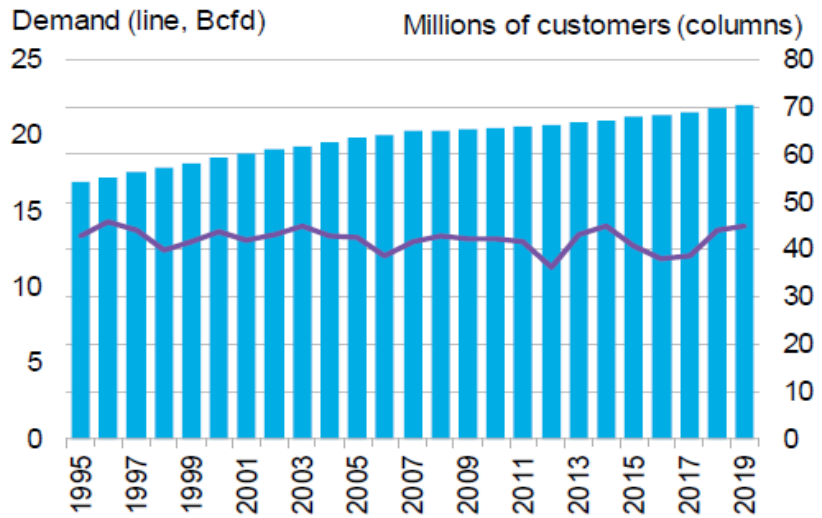
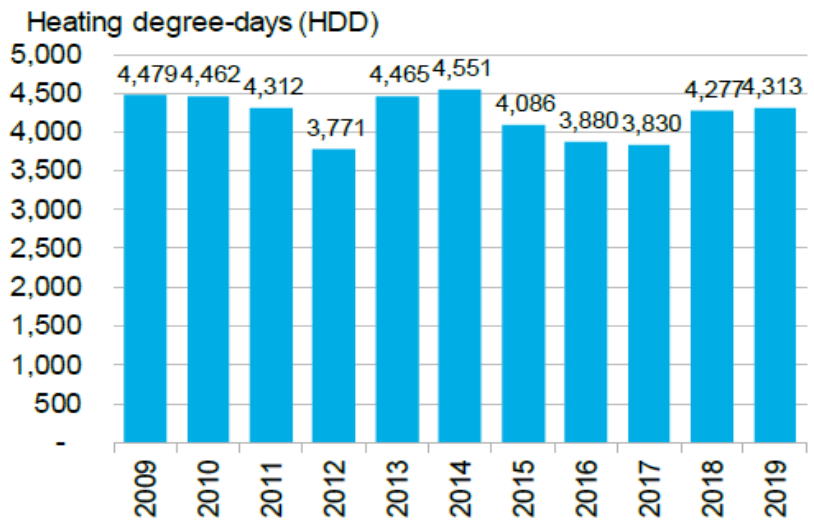
# Deployment: U.S. natural gas residential customers vs. consumption

## Residential demand vs. consumption




## Heating degree-days

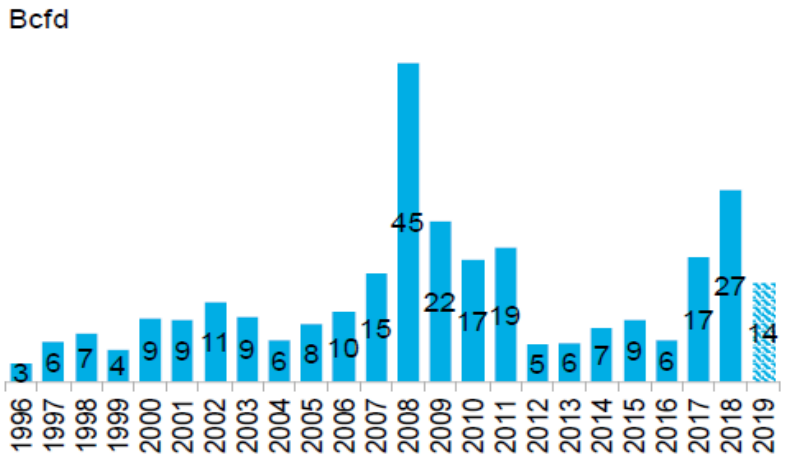



- Residential natural gas consumption decreased by 2% in 2019 even as the number of customers grew by 1%. The customer base for residential gas has expanded by 5 million, or 8%, in the last decade – and by 12.1 million, or 21%, over the past 20 years. Meanwhile, residential consumption remained largely flat over the same time, rising 7% in 10 years, but only 8% in 20 years, due to efficiency gains in the use of gas.
- Residential gas consumption is volatile year-to-year as it's driven by weather patterns. Consumption dropped during the abnormally mild winter of 2012, which saw a 13% fall in the number of heating degree days from the previous winter. It then jumped during the polar vortices of 2013 and 2014. Year-on-year, 2019 will see a 1% rise in demand, partly due to atypically cold weather holding for the second year in a row.

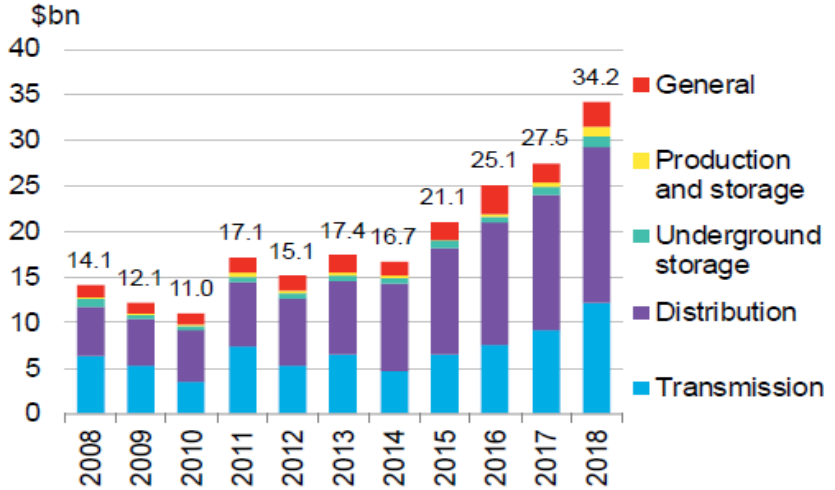
*Source: BloombergNEF, EIA Notes: Values for 2019 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2019). Heating degree-day data is available through September 2019.*

# Deployment: U.S. midstream infrastructure capacity and investment

## U.S. transmission pipeline capacity additions




## U.S. midstream gas utility construction expenditures

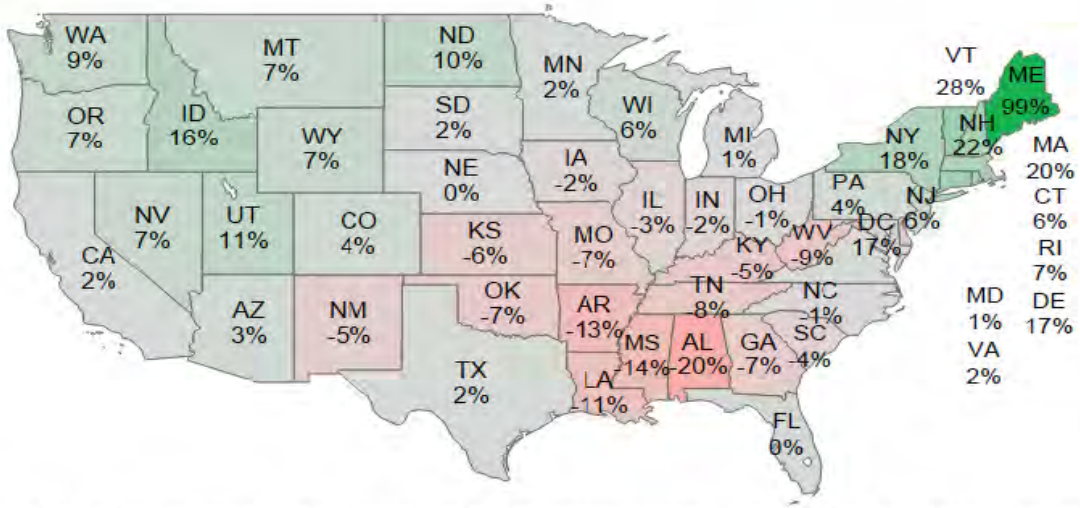



- Completion delays at the end of 2018 resulted in a lower-than-expected total capacity additions in 2019. Growth in the lower 48 states pipeline network slowed in 2019. Only two new pipelines came online: Kinder Morgan's 2Bcfd Gulf Coast Express, which carries gas from the Permian to south Texas, and Enbridge's 2.6Bcfd Valley Crossing, which feeds into an export route to Mexico.
- Midstream expenditures kept rising in 2018, reflecting the strongest level of capacity additions since 2008. Total expenditure grew by 24% in 2018, after 25% growth in 2017. However, midstream investment appetite has begun to dry up with the 2018 MLP tax reforms and unfavorable market conditions for producers.

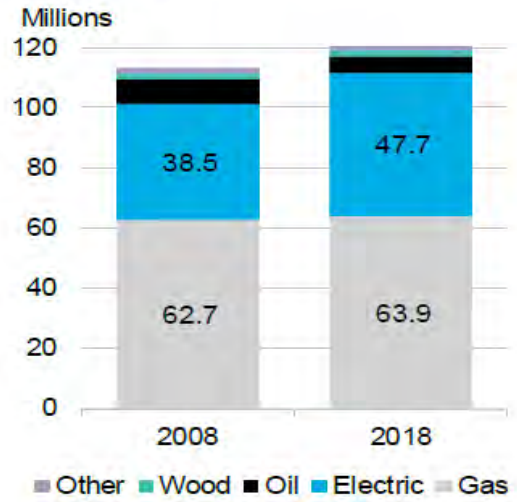
*Source: BloombergNEF, American Gas Association, EIA Notes: EIA data include both first-mile takeaway capacity and pipeline additions that do not impact takeaway capacity. 2019 transmission capacity is a BloombergNEF estimate. Expenditure values reflect figures reported to the AGA by companies across the supply chain, including transmission companies, investor-owned local distribution companies, and municipal gas utilities. "General"' includes miscellaneous expenditures such as construction of administrative buildings. Totals may not sum due to rounding.*

# Deployment: Heating demand for natural gas

## Percent change in households using natural gas for heating, 2008-2018




## Primary heating source by household




- Natural gas is the largest heating source in the residential sector, with 63.9 million homes heated by utility natural gas or bottled propane. That is equivalent to 52% of U.S. households. The second largest heating source, electricity, accounts for 39% of households.
- In absolute terms nationwide, the total number of households using natural gas for heating has risen by 2% since 2008.
- However, changes have varied substantially by region. On a percentage basis, usage grew swiftly in the New England states as the share of consumers burning more costly home heating oil dropped by double digits in many states. However, gas usage declined in other regions of the country, where electric heating gained popularity.

*Source: BloombergNEF, US Census Bureau*

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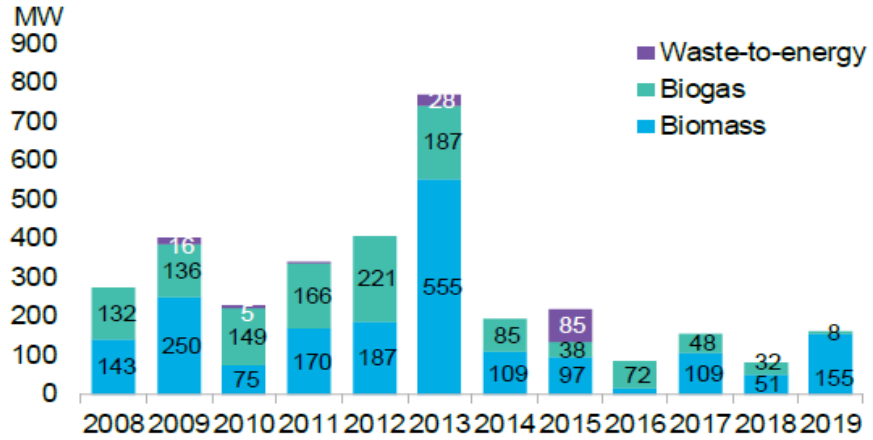
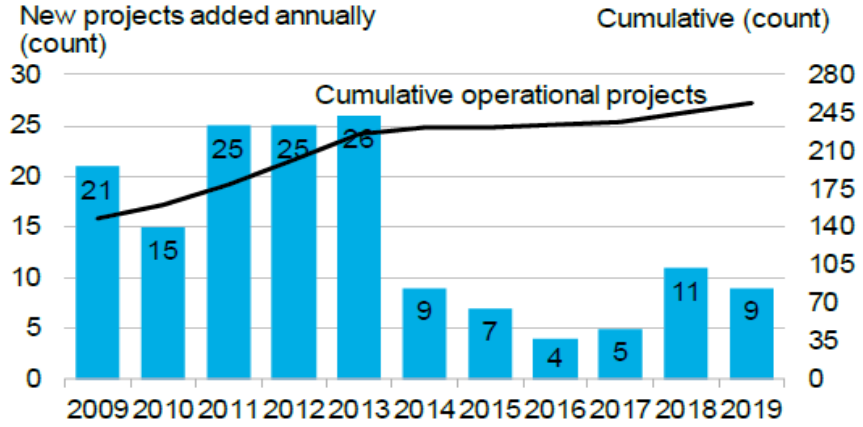
# Deployment: U.S. bioenergy and anaerobic digester build

## Annual build: large-scale bioenergy




## Annual build: farm-based anaerobic digesters




- In 2019, the U.S. installed 155MW of biomass and 8MW of biogas projects. Bioenergy build has tapered since 2013, when the Production and Investment Tax Credits, as well as the 1603 Treasury grant program, encouraged nearly 800MW of new installations. However, these technologies will benefit from the PTC extension that Congress approved at the end of 2019.
- Waste-to-energy technology has seen more growth in countries such as China, where 111 projects representing 1,800MW were awarded in 2019, up from 86 and 64 projects in 2017 and 2018, respectively. In all, 3,700MW of waste-to-energy projects is expected online in China 2018-2020. The U.K. also has provided important policy support to waste-to-energy. There are now 49 operational plants in the U.K., 12 under construction, 11 in advanced development and another 17 possibly on the way.
- Nine new anaerobic digesters were added in 2019 in the U.S. On average, since 2014, seven new systems have been built annually. The total count of operational projects (accounting for retirements) has increased 9% since 2014. In addition, there were nearly 775 operational landfill gas plants, 66 food scrap digester systems and 1,269 wastewater digester systems in 2019, not shown in the graphs above.

*Source: BloombergNEF, EIA, company announcements, EPA, WEF Notes: Biomass includes black liquor. Biogas includes anaerobic digestion (projects 1MW and above except wastewater treatment facilities). The graph on the right reflects anaerobic digesters on livestock farms in the U.S. and is sourced entirely from the EPA AgSTAR database.*

# The US Biogas Market

**Current**

**254** on Farm

**1,269** Water

**66** Food Scrap

**645** at Landfills

**Potential**

**8,300** on Farm

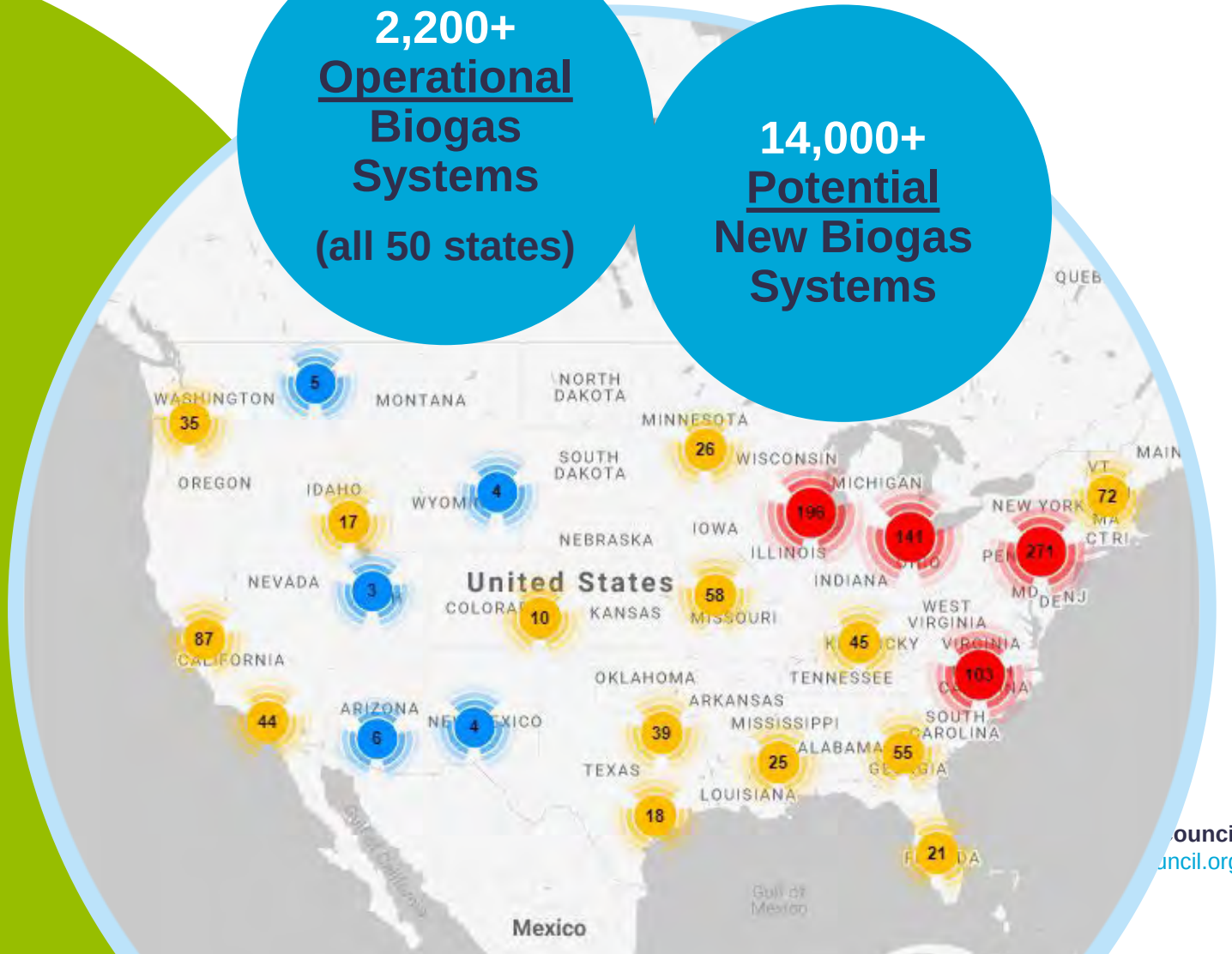
**4,000** Wastewater

**1,000** Food Scrap

**440** at Landfills

**2,200+ Operational Biogas Systems (all 50 states)**

**14,000+ Potential New Biogas Systems**

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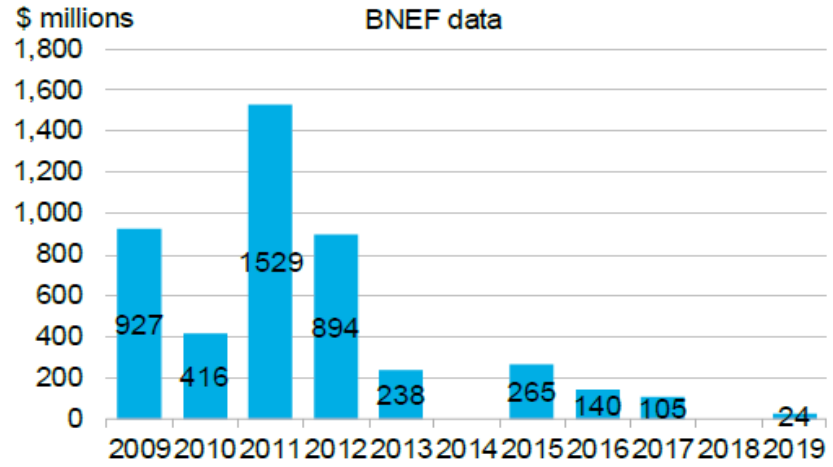
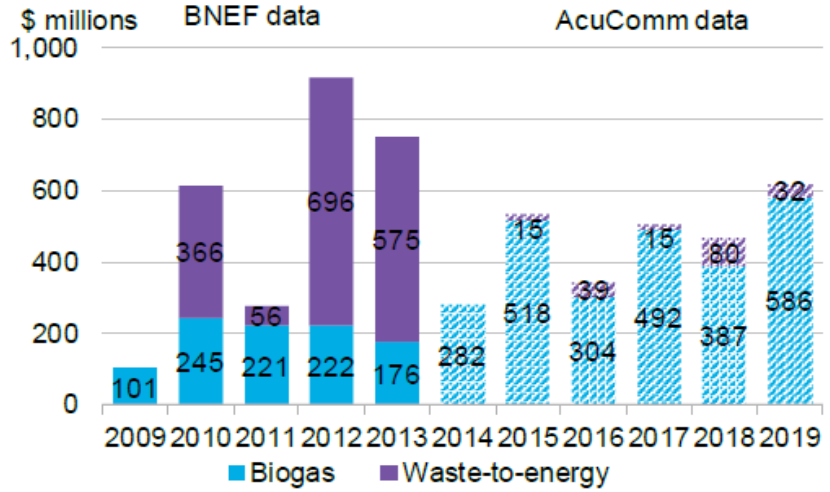
# Financing: U.S. bioenergy asset finance

## Asset finance for U.S. biomass




## Asset finance for U.S. biogas, waste-to-energy

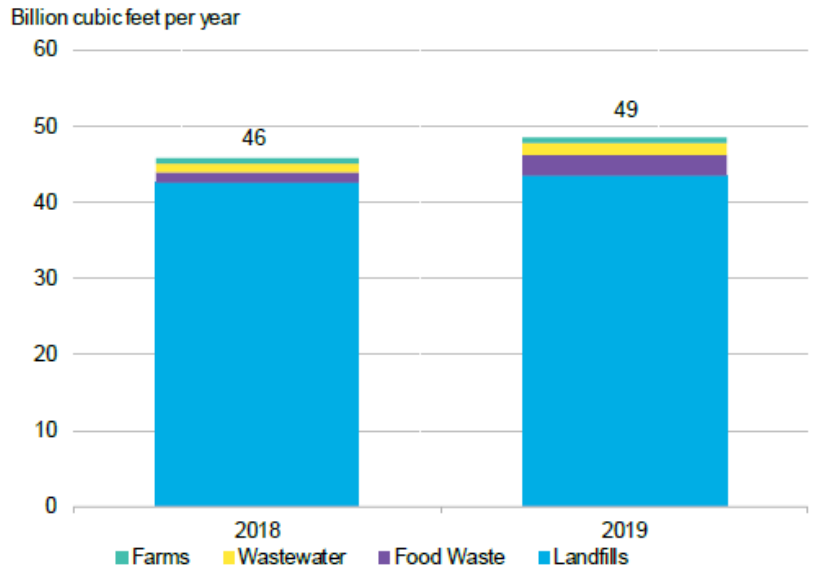



- Asset (project) finance for new biomass and biogas build continues to fluctuate, with an resurgence of biogas investment in 2017-2019. In 2019, AcuComm and BNEF tracked 15 investments into large biomass, biogas and waste-to-energy projects with a combined capacity of over 70MW and total investment value of $643 million, around double the capacity of – and 32% the investment value of – bioenergy plants financed in 2018.
- Lower investment for biomass in the past five years suggests that new build will continue to be subdued. Plants take two to four years to build and commission, so investment functions as a leading indicator for build.
- AcuComm is an alternate data provider providing coverage of select bioenergy plants throughout the U.S.

*Source: BloombergNEF, EIA, company announcements, AcuComm Notes: Values are nominal and include estimates for deals with undisclosed values. Biogas includes anaerobic digestion (1MW and above, except for wastewater treatment facilities) and landfill gas.*

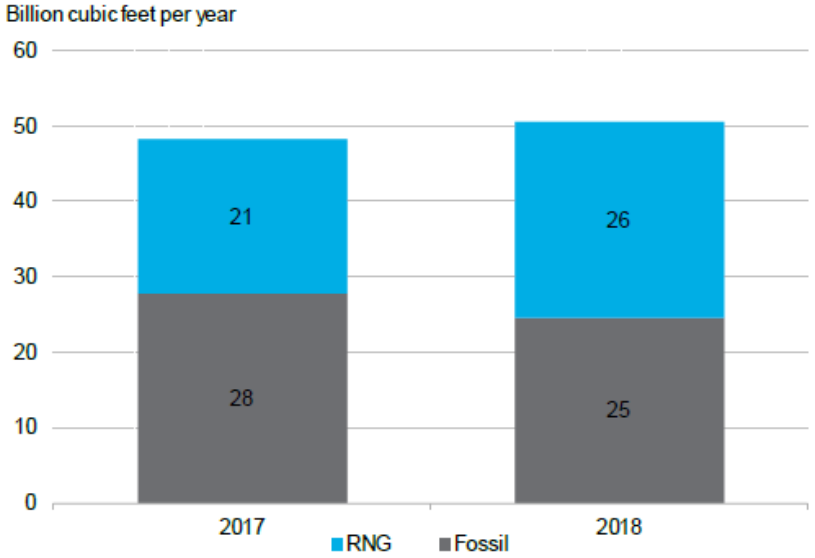
# Renewable natural gas (RNG) deployment: Production and use in transportation

## RNG production capacity, by source




*Source: The Coalition For Renewable Natural Gas, Argonne National Laboratory (As of June 2019)*

## U.S. natural gas vehicle fuel consumption

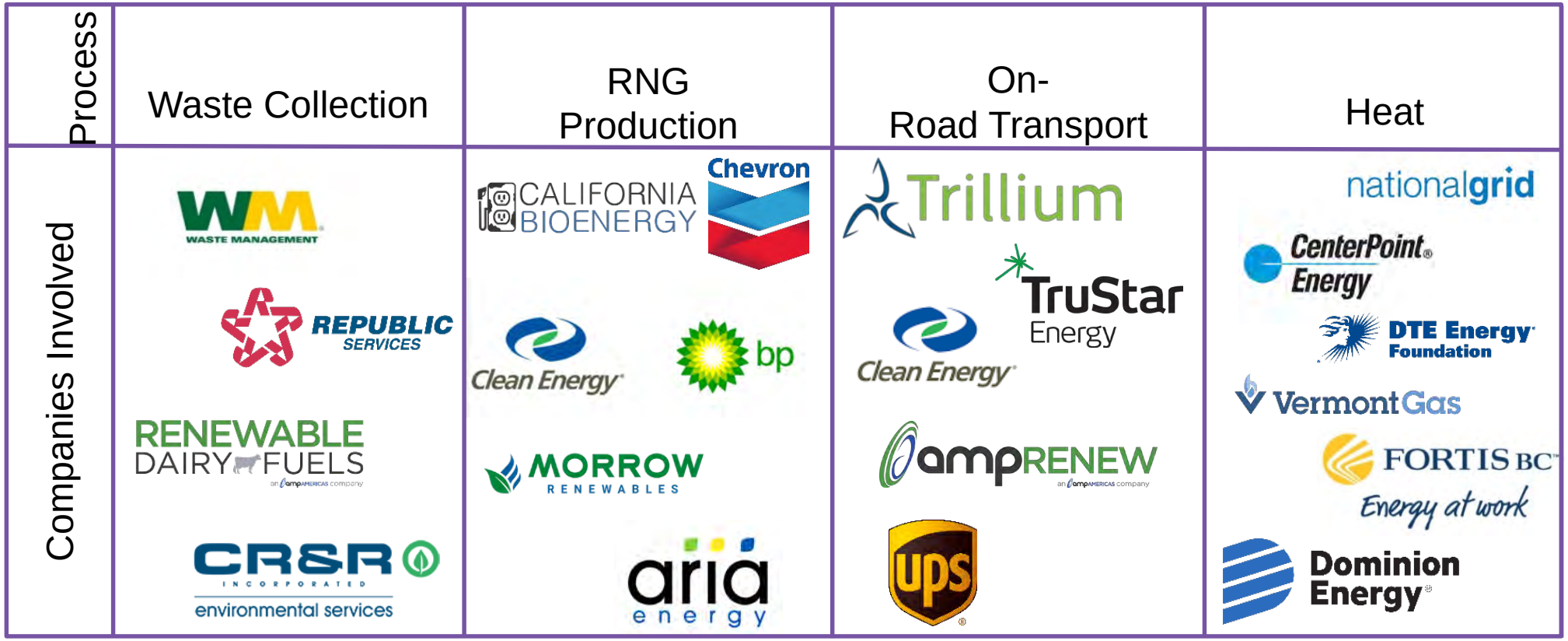



*Source: RNG: EPA – Moderated Transaction System, Fossil – EIA Natural Gas Consumption*

- The vast majority of U.S. RNG is produced through biological decomposition of waste in landfills. In 2017, RNG met 43% of natural gas demand from the transportation sector, according to the EPA and EIA. In 2018 (the last year for which complete data exists), that rose to 51%.
- Key drivers of consumption have been the California Low Carbon Fuel Standard and the national Renewable Fuels Standard. Under the latter, credits known as renewable identification numbers (RINs) are critical to making RNG competitive, specifically "D3" RINs. In 2019, prices for RINS collapsed 57% from approximately $2.04/RIN in January, to $0.87 in October, according to the EPA. This drastic drop in price was triggered by small refinery exemptions granted by the EPA that diminished demand for D3 RINs.
- There were also and estimated 5.24 million gallons, 5.9 million gallons and 5-6.5 million gallons of U.S. renewable propane production in 2017, 2018 and 2019, respectively.

*Source: BloombergNEF, FERC*

# The RNG value chain




*Source: BloombergNEF Note: Waste Collection is defined as the processes of landfilling, waste water treatment, animal manure management and food waste gathered from residential or commercial facilities*

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